Development of Methodology for Determining Future Emissions

Author(s): Zhining Tao[1], Allen Williams[1], Geoffery Hewings[2], Kieran Donaghy[3], Donald Wuebbles[4]

Affiliation(s): [1]Illinois State Water Survey, University of Illinois at Urbana-Champaign (UIUC); [2]Department of Geography, UIUC; [3]Department of Urban and Regional Planning, UIUC; [4]Department of Atmospheric Sciences, UIUC

Background

Large anthropogenic emissions leads to adverse effects 1) on human health, e.g. respiratory disease; 2) on ecosystem, e.g. plant disease and crop yield; 3) and on environment, e.g. acid rain, visibility, and climate. Society reaches consensus to reduce emissions to protect human and environmental health. How much should emissions be reduced to achieve balance of welfare and environment, and to sustain development? Emission inventory is key to answering the question.

Method

1) *Emissions = EMI x activity*

EMI - emission intensity;

activity - economy, energy, population, etc.

2) $EMI_t = EMI_0 \times (1 + \frac{rate}{100})^n$

EMI_t - EMI for future year t;

EMI_0 - base year (1999) EMI;

rate - average EMI change (%)

n - number of years from 1999

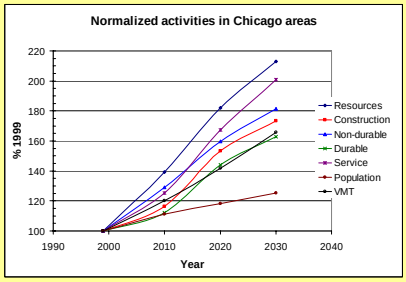
Economic activity is estimated using a Regional Econometric Input-output Model (REIM); other activities include 1) energy usage (Department of Energy); 2) vehicle mile traveled (Department of Transportation); 3) population (U.S. Census Bureau).

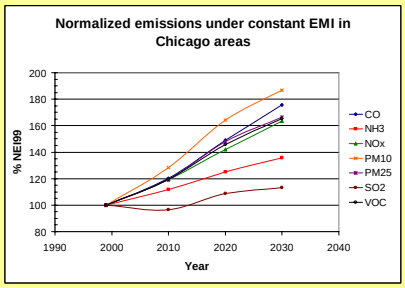
Base year EMI is estimated using the National Emissions Inventory 1999 (NEI, U.S. Environmental Protection Agency) and activity data outlined above. NEI is organized based on Source Classification Code (SCC), and REIM is indexed to Standard Industrial Classification (SIC) code. Mapping approximately 10,000 SCC to 53 SIC is a key process.

EMI average change rate is calculated using the EPA's National Emissions Trend (1970-2002) and past activity data. The average EMI change rate is assumed to continue into future, thus future year EMI can be estimated using equation (2).

Chicago Case Study

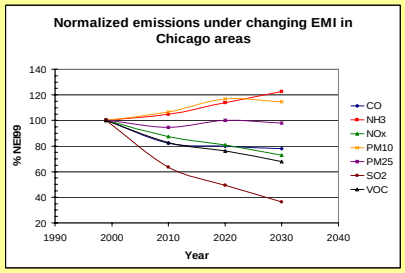
Cover 6 counties: Cook, DuPage, Kane, Lake, McHenry, and Will

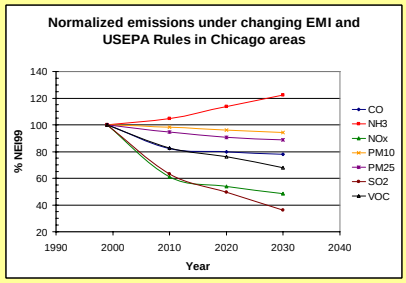




Under constant EMI scenario, difference in magnitude between activity and emissions changes reflects the economic structural change in Chicago area over next 30 year.

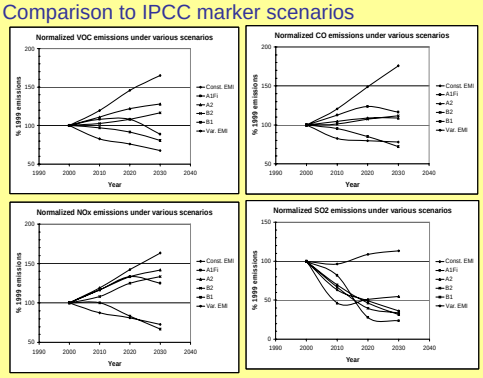
Two other emissions scenarios





EPA Rules: 1) Heavy-Duty Engine and Vehicle Emission Standards; 2) Heavy-duty Diesel Rule; 3) Clean Air Interstate Rule. Emission reduction at the average pace (changing EMI) is not enough to meet the USEPA's call for emission reductions in NOx and PM by 2030 in Chicago area.

Comparison to IPCC marker scenarios



IPCC scenarios for Organization of Economic and Development (OECD) region were selected and compared.

Emissions under the constant EMI scenario are higher than any IPCC scenarios, and emissions under the time-varying scenario are among the lowest. This indicates that our model predictions reasonably represent a wide range of scenarios.

We also compared our emissions under constant EMI scenario to predictions by the USEPA's Economic Growth Analysis System (EGAS). Our projection is lower than EGAS's prediction, indicating the important role of emission activity level in future emission projection.

Future Study

1) Transform SIC based REIM to the North American Industry Classification System (NAICS) based REIM (analysis under way); 2) Complete the continuous-time REIM development to support out-of-sample simulations so that we can formulate a much wider range of scenarios; 3) Expand the REIM to the entire Mid-west region to support emissions scenario development; 4) Develop method to convert SIC emissions to SCC emissions so that they can readily be used by impact studies.

This research is funded by U.S. EPA - Science To Achieve Results (STAR) Program Grant # R831449

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